COUNTER-WMD CONCEPTS OF OPERATIONS AT U.S. AND ALLIED AIR BASES

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Disclaimer

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Laura J. Le Gallo has over 5 years of experience as an Operations Research Analyst focusing on the effects of weapons of mass destruction (WMD), specifically chemical and biological warfare weapons, on operations at key military sites (both homeland/ domestic and international sites to include the Pacific, European and Southwest Asian theaters) and analyzing the implications of those hazards for current and future theater operational planning, acquisition and force structure. These analyses have been conducted in support of a number of DoD customers including the Air Force Directorate for Nuclear and Counterproliferation HQ USAF/XON (now XOS), the Defense Threat Reduction Agency (DTRA), MARFORPAC, U.S. Forces Korea (USFK), and 7th Air Force (& AF). This work has been paramount in revealing the complexities that adversaries face with regards to delivering sustainable chemical or biological hazards to fixed sites and has directly influenced CINC

OPLANS, Service CONOPS and TTPs and several related ACTDs. She holds a Bachelor's Degree from the University of Virginia in Biology and is completing a Master's Degree in Systems Engineering from George Washington University. Additionally, Ms. Le Gallo has analyzed passive and active defense postures currently used by the U.S. and its allies, and the impact of attack operations on strategic sealift and airlift operations, intra-theater airlift, and tactical air and port operations. Both the integrated methodology and the associated tools Ms. Le Gallo used to perform the aforementioned analyses are broadly recognized as unique in the level of site-specific operational detail and fidelity that they address and their ability to quantify the interdependencies between passive defense, active defense and attack operations / counterforce.

Mr. John P. Lawrence is the chief scientist and manager of the Operational Planning and Assessments Department of Science Applications International Corporation. Mr. Lawrence has a history of hands-on, highly responsive technical support involving WMD proliferation issues and CBW proliferation for OSD, DNA, CIA, DOE, ACDA, and the National Laboratories. Mr. Lawrence participated in the SHAPE analyses that formed the basis for the SHAPE post-Cold War CP triad, SHAPE TMD MOR, and NATO TMD concepts. Since joining SAIC in 1988, Mr. Lawrence has led the analysis efforts of a series of operational impact analyses conducted for the Air Staff, the Joint Staff, and CINCUNC Korea, which quantifies the impact of CB WMD attacks on operations at key APODs, SPODs, and fighter bases. This work has been central to uncovering "new" science with respect to the difficulties adversaries face with delivering a sustainable hazard environment at these fixed sites. The methodology is broadly recognized as unique, both in the level of operational detail it addresses and the ability to directly measure the interdependencies between passive defense, active defense, and counterforce. It has been the basis for both direct changes to CINC OPLANs, Service CONOPs, and operational procedures. Mr. Lawrence graduated from the United States Military Academy with a Bachelors of Science in Nuclear Engineering. He spent 9 years in the United States Army, with 4 years serving as a Nuclear Weapons Development Staff Officer.

Mr. Bert A. Cline is a Senior Analyst at Science Applications International Corporation and has over 26 years of experience in the U.S. Air Force. Mr. Cline contributed to the development of a methodology for the USAF assessment of Pacific Air Forces Concept of Operations and authored the PACAF Chemical Warfare CONOPS that was implemented AF wide. Further, he was a major participant in the successful development and implementation of the Restoration of Operations Advanced Concept Technology Demonstration that provided validation of the counter-chemical warfare CONOPS. While in the Air Force, he held numerous Disaster Preparedness positions, an Inspector General position, and served as a Theater Nuclear, Biological, and Chemical Defense Advisor, Superintendent of the Readiness School, and was a Major Command Readiness Manager. Additionally, he authored the Desert Shield/Desert Storm NBC Defense portion of the War Plan, the NBC portion of current U.S. Air Forces in Europe and PACAF War Plans, and the USAFE Component Response for Nuclear Weapons Accident Response. Mr. Cline has contributed to numerous SAIC studies and analyses and developed the seven-day Civil Engineering Readiness C-CW CONOPS MAJCOM/Wing orientation session, which included lesson plans, tabletop exercises, and progress checks.

Counter-WMD Concepts of Operations at U.S. and Allied Air Bases

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I. Introduction

In the face of U.S. military superiority, potential adversaries have begun to turn to asymmetrical means as a way to counter that capability. Our adversaries understand that U.S.-led coalitions will dominate the battlespace, if given the opportunity to flow their forces. Likewise, adversaries may try to inflict casualties on U.S. and allied forces early in the conflict in an attempt to make the coalition lose its "will" to fight. Such attacks are likely to include one or more elements of chemical, biological, radiological, nuclear, and high-yield explosives (CBRNE) warfare.

Recent events such as the terrorist attacks of September 11, 2001, the subsequent dispersal of anthrax-contaminated letter threats, North Korea's October 2002 declaration of the reactivation of their nuclear facilities and missile testing programs, and the threat, fortunately unrealized, of Iraqi use of chemical and biological weapons against coalition forces in Operation Iraqi Freedom, highlighted the specter of weapons of mass destruction (WMD) use and brought it to the forefront of our national security challenge as well as our national interest. Of equal concern is the availability of an extensive range of advanced weapons and technologies, dual-use production and storage facilities, and scientific/technical know-how that has accelerated the proliferation of WMD capabilities.

The number of likely adversaries pursuing these weapons is growing, and the potential for increased production and sales of weapons of mass destruction between both state and non-state actors, such as terrorist groups, is of serious concern. Secretary of Defense Rumsfeld addressed this increasing capability of our adversaries in June 2001.

> We do know that countries that do not wish us well have an enormous appetite for weapons of mass destruction and the ability to deliver them. We know North Korea does, and we know they've launched a two-stage [missile] with a kick motor for the third. With an ounce of luck, it could have been in orbit and would have inter-continental ballistic missile range. Everyone said they couldn't do it; how could those people who were starving, how could they possibly develop the kinds of system integration capabilities that would enable them to do that? They did it.[1]

Since the end of the Cold War, the threats and challenges faced by U.S. and allied forces changed dramatically. Many of the assumptions that had long dominated U.S. defense strategy, policy, doctrine, and force requirements no longer apply in today's new security environment, characterized by the rise of well-armed regional aggressors as well as smaller, non-state actors with the demonstrated desire and intent to acquire or develop WMD along with suitable delivery means. While a new focus has emerged regarding the homeland threat, the U.S. still faces serious threats to its military forces overseas. Potential regional adversaries are very likely to turn to WMD, particularly chemical weapons, as a way to blunt superior U.S. military strength during the course of hostilities. This monograph will explore, in depth, the improvements that have been made to operate in the chemical threat, and just as importantly but in less detail, the biological and radiological weapons threat.

II. USAF's New Understanding of the Chemical Threat

Since U.S. Air Force (USAF) units traditionally deploy to strategic forward operating locations early in a conflict, they are extremely vulnerable targets to chemical warfare (CW) attacks. This is particularly significant given the U.S. Air Force need to freely operate and sustain high sortie generation operational tempo (OPTEMPO) from these fixed sites, and is crucial to deterring and defeating the adversary. However, until recently, the ability to resume flying operations in the wake of a chemical attack has been hampered by assumptions of a "worst case" scenario in all cases, which required personnel to don their protective equipment and remain in mission-oriented protective posture level four (MOPP 4)[2] for extended periods of time.[3]

A central feature of the prevailing "worst case" approach was the familiar "slimed base" environment. The underlying assumption was that enemy missile, air, and special operations forces (SOF) attacks could strike with enough frequency and intensity to create chemical hazards that were highly lethal, pervasive, and persistent. Consequently, the base populace was forced to spend extended periods in MOPP 4, until chemical reconnaissance efforts either (a) determined that a chemical agent had not been used; or, more typically, (b) remediated the hazard, generally through a lengthy and resource-intensive decontamination process.[4] Regardless, it was anticipated that personnel would likely spend hours to days operating and living in MOPP 4. This "worst case" approach had driven Air Force planners to accept substantially degraded operations as an unavoidable consequence of a CW attack. Considering this an unacceptable result, Air Force Senior Leaders directed a re-examination of these threats and the associated concepts of operation to mitigate the effects of a CW attack.[5]

Subsequently, tests, studies, and analyses sponsored by the USAF, Defense Threat Reduction Agency (DTRA), Joint Service Materiel Group (JSMG), West Desert Test Center (WDTC), and the Naval Surface Warfare Center (NSWC) at Dahlgren, Virginia, provided a greater understanding of chemical effects on air base operating surfaces. These results, coupled with a more detailed understanding of the threat and the delivery environment, including the real world limitations of the delivery systems, overlaid on the operations at a fixed site, revealed that by improving tactics, techniques, and procedures and adding several new

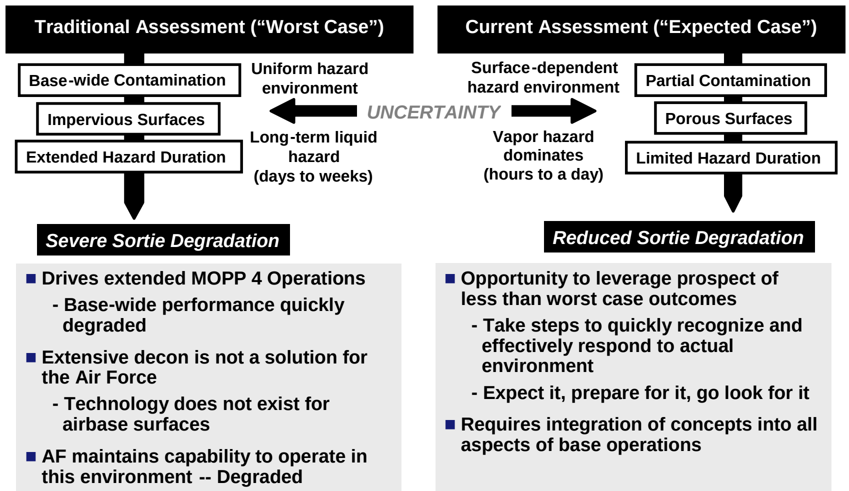
technologies, aircraft sortie rates could be maintained even after CW strikes. As highlighted in the Air Force Senior Leaders Guide Update 2002, a revised understanding of the CW threat was evident. Many of the previous passive defense measures underpinning the USAF Nuclear, Biological, and Chemical (NBC) Defense concept of operations (CONOPS) and procedures were disproportionate to the actual threats, risks and hazards, even in worst case scenarios.

Perhaps the most significant conclusion to emerge from the past several years of testing and analysis is the realization that an Air Force Counter-Chemical Warfare concept of operations (C-CW CONOPS) must be tailored to address a range of potential contamination environments. The extensive analyses suggested that developing CONOPS designed to exploit less severe environments, while retaining the ability to survive and operate in "worst case" environments, provided the potential for significant operational payoff. This approach was consistent with the common operational philosophy of protecting against the "worst case" but planning for the "expected case." See Figure 1 for a graphic representation of this shift in thinking from the traditional ("worst case") assessment to the current ("expected case") assessment. This adaptable and responsive philosophy (current assessment) underlies the approach the USAF recently has taken in developing a revised CONOPS for air base operations in a chemically contaminated environment.

The C-CW CONOPS includes procedures and risk-based decision aids that are designed to improve leadership's ability to determine the specific nature of contamination following a CW attack. While it requires new guidance and training, the CONOPS is expressly designed to be institutionalized throughout the existing doctrine, organization, training, material, leadership, personnel, and facilities (DOTMLPF) readiness domains of the Air Force.[6]

With a properly trained force, this knowledge allows appropriate post-attack actions to be taken that increase operational capability. The ultimate effectiveness of the C-CW CONOPS is driven by an installation's ability to implement and manage a decentralized split-MOPP[7] environment, the availability and employment of chemical contamination avoidance mechanisms, and tailored, site-specific procedures that balance force (personnel and equipment) survivability and mission production.[8]

Figure 1. Range of Potential Contamination Environments From "Worst Case" to the "Expected Case"



NOTE: ***The uncertainty in the ability of an air base to complete its mission in the event of a CW attack is driven by the level to which that air base is able to implement and leverage the C-CW CONOPS***

Although the primary focus over the last few years has been directed at understanding and quantifying the chemical threat, the Air Force is beginning to apply that same rigor to understanding the biological, nuclear, radiological, and high-yield explosive threats that exist in today's battlespace. While the C-CW CONOPS is approved and is being implemented throughout the USAF, the development of counter-biological, radiological, nuclear, and (high-yield) explosives CONOPS elements should ultimately lead to a singular, unified C-CBRNE CONOPS. This is the goal of the Air Force C-CBRNE Master Plan and its roadmaps.

III. Background: History of the Air Force Counter Chemical-Warfare Readiness Initiative

In the mid-to-late 1990s, a series of high-level war games and exercises[9] raised concerns about the Air Force's ability to fly strategic airlift into an air base contaminated with chemical warfare agents.[10] In 1998, DTRA and USAF Headquarters, Nuclear and Counterproliferation Directorate (HQ USAF/XON) co-sponsored a study to address this issue.

This analysis, commonly referred to as the "Aerial Port of Debarkation (APOD) study,"[11] found little basis for the generalized assumptions regarding the impact of chemical weapons on airlift operations. The relatively limited agent payload and inaccuracy of theater ballistic missile-delivered chemical weapons made it unlikely that the threat could contaminate an entire air base on a repeated basis. Moreover, the existing hazard duration estimates which came from existing manuals did not address concrete, asphalt, and painted metal equipment used at air bases. Existing test data suggested significantly shorter liquid contact and vapor hazard duration than traditional estimates. The APOD study quantified the operational opportunities that the expected shorter hazard duration period created in terms of risk to aircraft contamination and impact on deployment flow. This, in turn, raised the operational importance of developing a better understanding of the fate of chemical agent on different surfaces.

The results of subsequent live agent testing[12] at Dugway, the Czech Republic, and the Naval Surface Warfare Center confirmed that the liquid contact and vapor hazard duration is likely to be significantly shorter than previously assumed.[13]

Based on this new understanding and the comprehensive reexamination of historical test results, the Commander of the Pacific Air Forces (COMPACAF), General Pat Gamble, in June 1999, directed Headquarters Pacific Air Forces (HQ PACAF) to develop revised procedures for air base operations in a chemically contaminated environment.

The Pacific Air Forces C-CW CONOPS[14] was built on the premise that it was possible to achieve dramatic improvements to mission-critical measures of success (i.e., sorties flown) while simultaneously strengthening the overall force protection posture of the air base. This

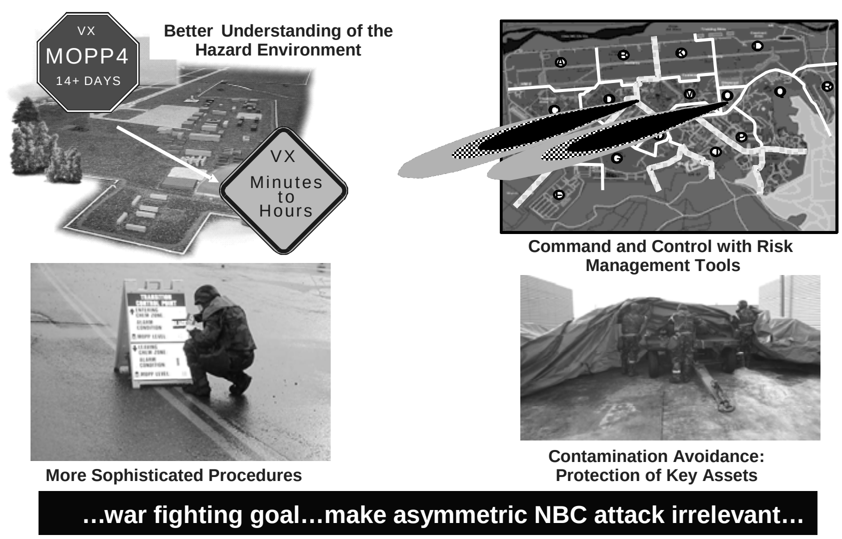
called for a "holistic" approach that took an end-to-end look at current and emerging threats, conducted thorough hazard analyses, and applied the best available science to determine the safest, most effective passive defense measures consistent with the operational imperative of continuing the mission.[15]

In December 2000, COMPACAF sent out a memorandum that directed his forces to implement the revised C-CW CONOPS and recommended its implementation throughout the Air Force. In January 2002, the Chief of Staff, United States Air Force (CSAF) directed its implementation Air Force-wide.[16]

IV. The USAF C-CW CONOPS

The Air Force C-CW CONOPS has four major tenets based on a risk management approach that recognizes there are gaps in the underlying empirical knowledge base. (See Figure 2.) The CONOPS articulates this better understanding of the hazard environment in an operationally meaningful way. It provides procedures and tools that enable commanders to determine the specific nature of the contamination after an attack and take appropriate pre-attack (contamination avoidance procedures) and post-attack (command and control decision-making) actions to leverage opportunities to increase operational capability.

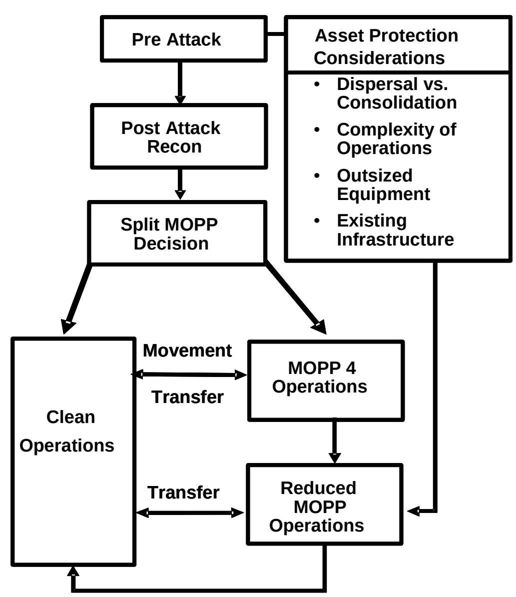
Figure 2. Four Major Tenets of the USAF C-CW CONOPS



USAF C-CW CONOPS Execution

When warning of attack is received, it will be disseminated across the base, and personnel will don their protective equipment (MOPP 4), seek cover, and the basic flow of C-CW CONOPS (Figure 3) will be followed. Personnel will remain under cover in MOPP 4 until directed to resume operations. In all but the most time-sensitive, critical mission operations, it is prudent to limit operations outside until the droplet deposition period is complete to minimize the risk of direct liquid contamination. Once the attack is over, post-attack reconnaissance activities will be conducted to determine the extent of contamination across the base. The results of this reconnaissance will allow the commander to direct portions of the base that were not contaminated during the attack to reduce MOPP levels while operations in contaminated areas will continue in MOPP 4.[17]

Figure 3. Basic Flow of Operations on an Air Base under the USAF C-CW CONOPS



Due to the lack of automated liquid agent detectors or vapor detectors sufficiently sensitive to detect liquid deposition of low volatility agents, like VX, pre-positioned M8 paper[18] must be used to determine where the contamination occurred. Follow-on monitoring of surfaces known to have been contaminated enables the base to determine for itself whether or not the agent has sorbed[19] into the operating surfaces. Again, using M-8 paper, base personnel can determine the contamination status of vehicles, equipment, and aerospace ground equipment/materials handling equipment (AGE/MHE).

Operations in contaminated areas will continue in MOPP 4 until the hazard from the concrete and asphalt operating surfaces no longer requires this level of protection. This timeframe, when personnel will be required to wear MOPP 4, will be driven by the vapor hazard generated by the off-gassing of agent sorbed into the operating surfaces. This determination will initially be based on detector readings.[20] In most cases, existing detectors will not be sufficiently sensitive to detect low levels of off-gassing agent, requiring the commander to assess his/her mission requirements against the risks associated with reducing MOPP levels in these areas. The range of hazard times depend on height of burst of the missile, wind speed, air temperature, and air stability. This range of hazard times illustrates the uncertainty that commanders must be aware of when reducing MOPP levels since it represents a time of rapidly decreasing risk, where the agent is below acute lethal or incapacitating effects and designed to protect personnel from the lowest level eye effects.[21]

Even after MOPP levels in contaminated areas have been reduced, MOPP 4 operations will continue when operating in or directly around vehicles, equipment, AGE/MHE, and munitions that were contaminated during the attack. These items represent both painted and bare metal surfaces that are expected to support a longer-term hazard than the surrounding concrete and asphalt operating surfaces. The C-CW CONOPS provides procedures for limited operational decontamination to remove any liquid that may be remaining on these surfaces. These expedient decontamination actions will not be sufficient to reduce MOPP levels solely because of their completion. Rather, expedient decontamination of these specific surfaces can minimize the risks and probabilities of inadvertent personal contact and cross-contamination. The inability of any fielded decontamination technique to neutralize all chemical hazards is primarily

due to the porous quality of most surfaces found on an air base, to include the paint used on most USAF assets.[22] Much like the operating surfaces, these paints sorb agent within minutes. While the liquid contact and transfer hazard dissipates quickly, a vapor hazard will remain for some period. The ability of an air base to have vehicles, equipment, AGE/MHE, and munitions covered at the time of attack is an important element of contamination avoidance, because of the inability to completely neutralize chemical agents once they have sorbed into most surfaces. The benefits of covering critical assets pre-attack are increased personnel safety, the absence of cross-contamination through inadvertent agent transfer, and reduced MOPP 4 timelines.

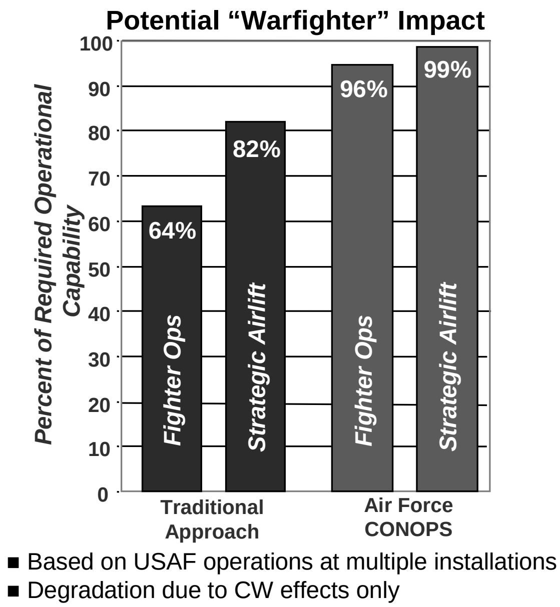
Procedures for managing operations in MOPP 4 must be maintained. These include: capabilities for shelter management, contamination control areas, and chemical exposure control activities. These procedures remain in place to ensure the air base can continue to safely operate in MOPP 4 for as long as the hazard warrants. If the hazard is of relatively short duration, the air base is positioned to determine this and take advantage of the opportunities afforded. If, on the other hand, the hazard is of a longer duration, then all the procedures to sustain MOPP 4 operations are provided.[23]

V. Understanding and "Operationalizing" the Science

As mentioned previously, the APOD family of studies[24] offered an alternative view to the Air Force's long-held assumptions and practices. The study concluded that chemical attacks are likely to affect a much smaller portion of fixed sites than originally believed. Likewise, pick-up and transfer hazards to equipment are likely to be of much shorter duration than previously assumed. While the chemical effects data on which these findings rest remain limited, all the available data points strongly to the conclusion that chemical agents will sorb quickly into porous concrete and asphalt surfaces of fixed facilities. While this will not eliminate the hazard posed by agents deposited on non-porous surfaces, it does suggest that with the appropriate command level understanding, command and control, CONOPS, and training, the operations tempo should be sustainable and war plans executable.

Building on the APOD family of studies, recent analysis of air base operations in a chemically contaminated environment as well as exercise results from Osan Air Base (AB) in the Republic of Korea, show that the negative impact on sortie generation under the C-CW CONOPS could be less than 10% after a CW attack rather than the expected degrade of 40% or more when using traditional approaches.[25] (See Figure 4.) The 51st Fighter Wing (FW) at Osan AB achieved this through a process that took the risk management guidance, tools, and procedures provided in the PACAF Counter-Chemical Warfare Commanders Guide and Technical Report, and with the assistance of a team of technical experts provided by the HQ USAF, tailored them to the Osan AB infrastructure and functional operations. The analytic results were most recently validated through operational exercise results during the Air Force-led, DTRA-executed Restoration of Operations Advanced Concept Technology Demonstration (RestOps ACTD) at Osan in February of 2001.[26] Key to the 51 FW success in reducing the negative impact of CW attack on sortie generation was their ability to assess operations across all wing functionals within the context of the new understanding of the air base CW environment as well as ability to identify which operations, if contaminated, posed greatest risk to full operational recovery, and develop strategies for mitigating those risks.

Figure 4. Potential Operational Buy-back Gained from Understanding and Implementing the C-CW CONOPS[27]



It is important to note that the Air Force C-CW CONOPS is a passive defense approach against chemical weapons. The Air Force must take an integrated and comprehensive approach across the counterproliferation spectrum, including proliferation prevention, counterforce/attack operations, active defense, and passive defense in order to achieve the maximum potential effectiveness in countering chemical weapons. This is critical to mitigating the threat.

VI. The Chemical Threat and Current Air Force C-CW CONOPS Implementation Initiatives

Comparison of Efforts from 1993 to present

The Air Force has made dramatic improvements in CW defense over the past decade. As a result, Air Force personnel have demonstrated the ability to significantly improve mission accomplishment while using tactics, techniques, and procedures (TTPs) that are much safer than those utilized circa 1993. Additionally, the Air Force has upgraded protective equipment and initiated and sustained a Mask Fit Validation Program. The following are some of the major differences between CW defense operations in 1993 versus those of today.

Evaluation of probable threat environment at air base (rear area fixed sites)

While in 1993 the Air Force understood that tactical ballistic missiles were the primary threat, versus manned fighters/bombers, the knowledge essentially stopped there. Over the past six years the Air Force conducted a scientific and analytical review to quantify the types and extent of probable chemical threats to the typical air base. Specifics of the review included missile payloads, missile accuracy, SOF delivery methods, and CW agent droplet sizes at time of release, deposition patterns, and more.

Use of split-MOPP operations

In 1993, while not a new concept, no Air Force-level guidance existed for split-MOPP operations, and the practice was not widespread. Consequently, a chemical attack would have resulted in an ineffective one-MOPP level attack response methodology. A split-MOPP response allows personnel in uncontaminated areas to rapidly reduce their protective posture and return to full operational capability with a minimum of risk.

De-masking techniques

In 1993, the standard de-masking technique was to use available chemical detectors to check for the presence of contamination, and then,

direct de-masking once chemical contamination ceased to register on the instruments. Upon further study, the Air Force determined this practice was unsafe. Although the liquid contact and transfer hazard dissipates quickly (most detection instruments only read liquid hazard), a potential vapor hazard will still remain thereafter for a certain amount of time depending on such factors as surface and weather conditions, during which masks will still be required until directed by the commander. The commander can use guidance in the USAF C-CW CONOPS to assist in this decision process.

Hazard duration projections

In 1993, the only document used throughout the Air Force that contained chemical hazard duration projections was the Allied Tactical Publication (ATP) 45, *Reporting Nuclear Detonations, Chemical and Biological Attacks, and Predicting and Warning of Associated Hazards and Hazard Areas*. The hazard duration table in ATP 45 is very general in nature, giving estimations such as three to ten days in the hazard area and four to six days downwind of the hazard area. Upon further study, the USAF determined these projections were extremely conservative and did not provide operationally-useful information. Consequently, the Air Force departed from the ATP 45 table and began to follow Persist 2, a chemical persistency program used by USAF Civil Engineer Readiness (CEX) personnel. As more information was provided and additional test results became available, the USAF then transitioned from Persist 2 to today's hazard duration charts.

Automated Hazard Prediction Plotting

In 1993, the Air Force did not possess an automated chemical hazard prediction plotting capability. Since that time, the Air Force has distributed an automated CW hazard prediction plotting capability to each CEX flight. This automated plotting capability is contained within the Vapor Liquid Solid Tracking (VLSTRACK) software package included as part of the Joint Warning and Reporting Network (JWARN) program. The Air Force provided training at each major command (MAJCOM) regarding automated CW hazard prediction plotting during C-CW CONOPS training sessions.[28]

De-emphasis of M17 Decontamination Apparatus and Specialized Contamination Control (Decontamination) Teams

In 1993, the Air Force had not finished reviewing the studies and test results that facilitated the removal of the M17 decontamination apparatus from wartime chemical-biological equipment sets.[29] The Air Force also still maintained a requirement for area (Civil Engineer), munitions, vehicle (Transportation), and aircraft (Maintenance) decontamination teams. Over the past decade, the futility of using the M17 decontamination apparatus for chemical decontamination hours after an attack has been clearly established[30] and studies have shown that large-scale decontamination efforts do not significantly reduce contamination in the expected threat environment. The subsequent Air Force elimination of the decontamination requirements has led to increased productivity and lessened the manpower requirement for wartime operations.

Matching equipment and resources to the threat

In 1993, the individual protective equipment (IPE) authorizations existed only for high chemical and biological warfare (CBW) threat areas. The concept of a medium threat area did not exist. Consequently, people were in an "all or nothing" condition in regard to IPE authorizations. The introduction of authorizations designed for areas that required some, but not all, IPE rectified this shortfall.

Further, in 1993, the Air Force's collective protection, or shelter program was essentially non-existent. The collective protection facilities in Korea were unserviceable and those in Europe were in the process of being removed or placed into long-term storage. Today, the collective protection facilities have been repaired and transportable collective protection systems have been introduced.

Incorporation of Nuclear, Biological, Chemical and Conventional (NBCC) Defense Training into Basic Military Training (BMT)

The Air Force recognized that all airmen required basic NBCC Defense Training, regardless of whether or not they were going to be assigned to a mobility position at their first installation. Consequently,

NBCC Defense Training is now part of the Warrior Week segment of enlisted Basic Military Training.

Incorporation of automated chemical detectors into a base-wide network

In 1993, all chemical detectors were stand-alone units – there was no system available that integrated the detectors into a single network that could be monitored and controlled from the Wing Operations Center. Today, those Air Force installations equipped with the Portal Shield biological detection system also have the M22 ACADA[31] included as part of a single, integrated chemical-biological detection network.

Operational Effectiveness Assistance

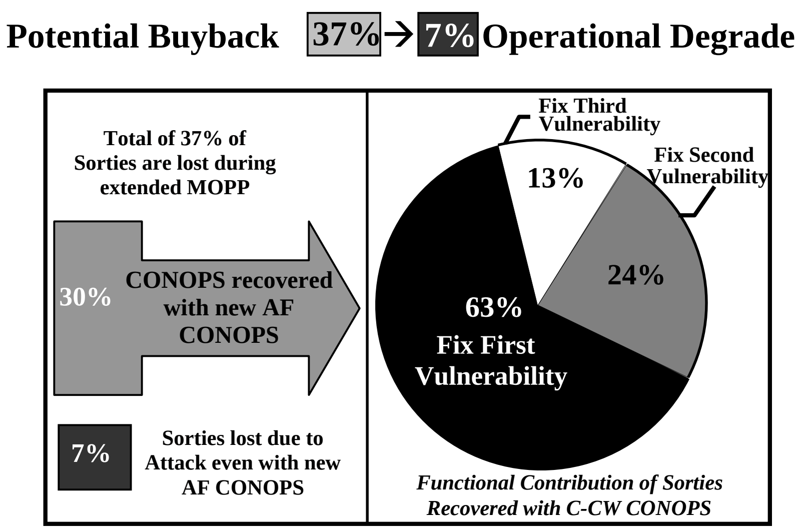
In addition to revisions to Air Force Publications (AFI 10-2501, AFH 10-2502, AFMAN 10-2602, AFMAN 32-4005 and AFMAN 32-4006) and the Full Spectrum Threat Response Plan 10-2, an important piece of the C-CW CONOPS implementation process, particularly for units forward deployed or responsible for contingency operating locations, is Operational Effectiveness Assistance (OEA).

Optimum C-CW CONOPS implementation benefits are realized when installations are able to manage a split-MOPP environment and identify and resolve vulnerabilities to chemical attack. Generally, such vulnerabilities may include a lack of infrastructure or barrier materials (or plans and procedures to use such contamination avoidance measures) to protect key assets prior to and during an attack. Examples of potential key assets may include munitions build and delivery equipment and vehicles as well as flight line maintenance equipment, etc. Additionally, inadequate command and control attack response procedures and timelines or lack of proper plans and procedures for establishing base sectors for split-MOPP operations can be other examples of vulnerabilities that are likely to require operations to be conducted in MOPP 4 unnecessarily. Resolving such issues can greatly improve both the timeliness and accuracy in understanding and resolving the actual contamination environment. The specific operational vulnerabilities are unique to each installation and are addressed accordingly through the OEA process. An Operational Effectiveness Assistance visit is performed by a team of subject matter experts. The OEA provides a detailed analysis of CW

vulnerabilities at an installation and quantifies the impact of mitigation techniques to minimize the effects of a CW attack. This is accomplished by developing a quantitative "operations baseline" of the installation's capability, key infrastructure, threats, and mission critical assets and then running models such as EXPEDITER, to identify high leverage, site-specific actions and mitigation strategies to improve mission capability in a contaminated environment. This offers the installation a tailored strategy for the C-CW CONOPS TTPs.

It is wise to tailor such TTPs to specific installations to achieve maximum operational pay-off in sortie generation and airlift operations. An example of this tailored approach can be seen in Figure 5, where 30% of the operational capability at a notional air base was regained by implementing the C-CW CONOPS and resolving specific operational vulnerabilities.

Figure 5. Example of the Impact of Base-specific Tailoring of the C-CW CONOPS on Sortie Generation Capabilities



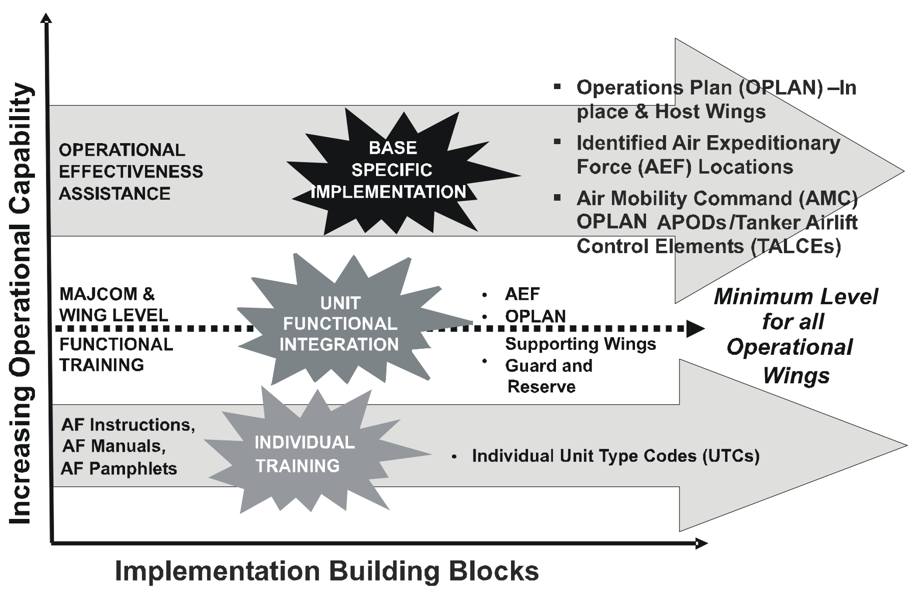
In this example, the base lost its ability to generate 37% of its sorties using the traditional CONOPS, but by introducing the USAF C-CW CONOPS, 30% of the sorties were recovered, leaving a total degradation

of only 7% of the sorties. What was required to gain back the 30%? In this example, three vulnerabilities were identified and each had a different level of improvement when the vulnerability was mitigated.

Education and Training

Successful implementation of the C-CW CONOPS in the Air Force requires a comprehensive program of education and training. This education and training regime must focus on the individual, his/her unit and the larger wing organization. (See Figure 6.)

Figure 6. Levels of Training Necessary for the Full Benefits of the C-CW CONOPS to be realized



At the individual level, airmen need to have a basic understanding of the C-CW CONOPS, the significance of various surfaces to potential contamination and the basic concepts behind split-base and split-MOPP operations. The airman must be able to use and care for his/her chemical protection equipment.[32] Finally, the airman must receive C-CW CONOPS

training relevant to his/her technical skill. This is best done during technical training. For example, a munitions specialist must understand the CONOPS in the context of munitions storage area operations.

At the unit level (flight/squadron) training must be provided in post-attack contamination assessment and reporting procedures.

At the wing level, within the command post, training needs to focus on assimilating reports and on assessing contamination and the associated impact on operations. Finally, the decision process to determine split-base/split-MOPP must be exercised using the various tables available. During exercises, the wing commander must assess the responsiveness of all subordinate units to the direction provided.

In a host of professional military education courses, the C-CW CONOPS must be taught and understood. Efforts are underway to infuse this course of instruction into Air War College, Air Command and Staff College, the Squadron Officer's Course, Basic Military Training, and a variety of commander's courses.

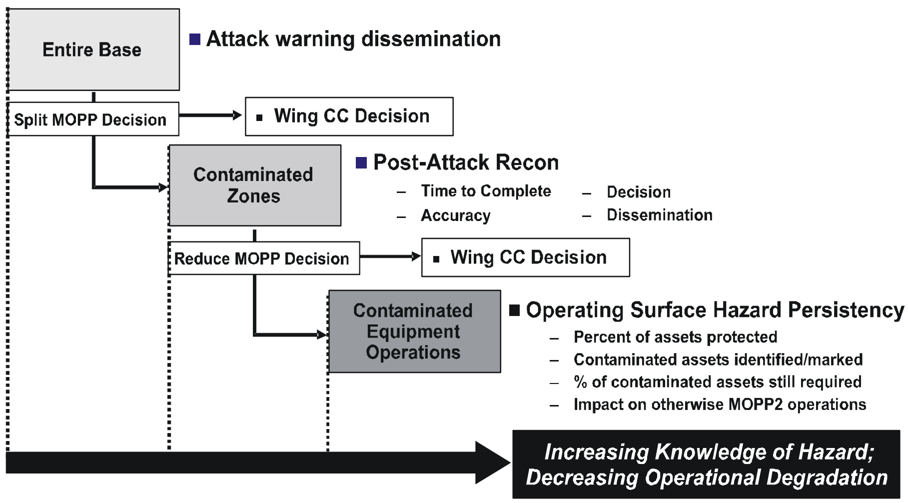
Finally, the Air Force needs to accommodate C-CW CONOPS training within the context of the Air Expeditionary Force (AEF). "Just-in-time" training at fixed locations and the use of mobile training teams will facilitate meeting this need. Additionally, training at the Air Mobility Warfare Center at Fort Dix, NJ, provides a basis of knowledge to future AEF support teams.

Command and Control (C2)

Successful implementation of the Air Force C-CW CONOPS requires a robust command and control structure from the Joint Force Air Component Commander level through the wing level. (See Figure 7.)

First, early detection of a theater missile launch is essential in order to start the theater warning process. Timely launch warning is fundamental to passive defense. Rapid dissemination of the launch warning throughout the theater command and control structure (and civil defense) requires a robust, redundant, C2 system.

Figure 7. Critical Areas of a Robust Command and Control with regard to Post-attack C-CW CONOPS Operations



Once warning is received at the wing level, the alert must be disseminated quickly and efficiently throughout the base. In established forward bases, this may involve Giant Voice (a base-wide loud speaker system), closed circuit TV, Theater Battle Management Computer Simulation, and telephone alerting. At expeditionary bare bases, the alerting requirement is no less real, but the means available to the wing commander may be limited. Base deployment kits need to accommodate this requirement. Base personnel must be able to receive the warning, don protective equipment, and take shelter within the remaining time of flight of the theater missile.

At the wing level, the wing commander must have the command and control tools to facilitate upward post-attack reporting in order to efficiently make the necessary operational decisions needed to restore combat capability. The C2 architecture must then support the dissemination of those decisions.

VII. Areas Still Being Addressed in the C-CW CONOPS[33]

Despite great strides in reducing degradation of operational capability through C-CW CONOPS implementation, there is significant room for improvement. The following items represent some examples of additional work to be done:

- Additional de-masking guidance is needed.
    - Tools specifically designed to assist in determining when it is safe to de-mask inside facilities that had chemical and/or biological contamination drawn in through the heating, ventilation, and air conditioning (HVAC) systems should be created.
    - An automated tool that factors in diurnal weather patterns into chemical hazard duration projections should be developed.
    - Criteria for determining when it is safe to de-mask when an overt release of CW agents has been detected, factoring in agent, weather, terrain, etc., should be established.
    - Tools specifically designed to assist in determining when it is safe to reuse tents and other temporary living/working quarters after they have been directly exposed to chemical or biological contamination should be considered.
- Contamination Control Area (CCA) activities require additional attention. A CCA is an area in which chemically contaminated individual protective equipment is removed; people, equipment, and supplies are decontaminated to allow processing between a toxic environment and a toxic free area (TFA); and people exiting a TFA may safely don IPE.[34]
    - Streamlined CCA procedures for ground crew, medical, and aircrew processing should be cultivated.
    - Clear guidance on 'who' must process through chemical CCAs does not exist (e.g., should everyone in a known contaminated area process through a CCA or only those with physical contamination on their ensembles?).

  - Definitive guidance does not exist in regard to the specific steps required for processing people (in IPE and/or civilian clothes) that have been exposed to a CW environment through a CCA.
  - Chemical mask refurbishment activities may not be cost-effective, especially when the availability of "required resources" is considered.

- All aspects of aircrew operations in a chemical and biological (CB) environment require additional attention.
  - Given aircraft environmental and life support systems, what protection is actually required to be furnished by CB IPE?
  - What individual protective equipment should aircrew have available during each phase of mission operations (i.e., preparing to fly in MOPP 2, preparing to fly in MOPP 4, post engine start, landing, etc.?)
  - Are current NBCC Defense and flying (in CB IPE) requirements sufficient?

- Standardized performance criteria should be developed for use at all levels of the Air Force in the Research, Development and Acquisition program to ensure adequate specifications are included as key performance parameters in Joint Operational Requirements Documents. An example would be that all chemical vapor detectors have the ability to detect and measure agents (to include known foreign variants) down to a level where miosis would not be reached after two hours of continuous exposure.

- All aspects of reconstitution operations require attention.
  - What specific special handling procedures are required for resources that were contaminated during hostilities?
  - What specific decontamination procedures will be used (resource by resource) to achieve the lowest possible level of contamination?

  - What will be done if detectors do not possess the sensitivity required to verify that contamination has been reduced to peacetime exposure standards?

- Specific guidance is required for contaminated waste disposal.
- Development and utilization of standardized Inspector General (IG) criteria for core CBRNE items should be implemented Air Force-wide, regardless of where the unit is located.

VIII. The Biological Threat and Current Initiatives

Biological weapons also pose a serious concern to national security. Recognizing this threat, the Air Force has made several great strides in the challenging area of biological defense since 1993.

Vaccination Programs

In 1993, the Air Force population as a whole was not vaccinated against BW agents. As seen in Operation Desert Storm, the response technique when entering a threat environment was to vaccinate personnel at the time of contingency plan execution. In most cases, Air Force personnel were vaccinated during deployment at the forward location rather than in the pre-deployment phase.

For the past several years, until late 2004, target populations received BW vaccinations based on their job and assignment/deployment status. However, in late 2004 and early 2005, anthrax vaccinations were halted due to a restraining order by a federal judge who mandated further safety tests. As of this writing the DoD is appealing this case, petitioning for the restarting of this important program. Up to the time when the vaccination program was stopped, it had become routine for personnel stationed in or deployable to BW high threat areas to receive anthrax vaccinations, regardless of the current defense condition level. Further, many medical care providers across the Air Force have been vaccinated for smallpox, regardless of whether or not they were stationed in or deployable to a BW high threat area. Given the shortcomings of BW agent detectors, these vaccination programs, if permitted, will provide the backbone of the personnel protection program, although many U.S. vaccines are either ineffective or are in very short supply against biological agents other than anthrax and smallpox, which are considered the top two BW threats.

Recognition that response to BW agents is not the same as response to chemical warfare (CW) agents

In 1993, there was little guidance available for how to respond to a BW attack. As a result, the conventional wisdom among leadership was to respond to BW attacks in the same manner as CW attacks. Over the last ten years, the Air Force has come to realize that chemical and biological

agents are very different from one another. For example, biological agents are very difficult to detect, and delayed symptoms may complicate medical detection. Further, the contagious nature of some BW agents and the toxicity of BW agents in comparison to CW agents lead to different considerations for BW versus CW. Due to these factors and others, the Air Force recognized that BW response should differ from CW attack response protocols in several key areas. For example:

- Recognition of BW attacks will likely occur as a result of trigger events that do not involve the actual detection of a BW agent through the use of a machine. These trigger events include intelligence warning, weapons event, and/or sentinel casualties. This use of trigger events differs from CW attack scenarios in that the use of detectors such as M8 paper will provide confirmation in most cases that CW agents were used in an attack.

- The use of split-MOPP procedures is generally not recommended for BW attack situations. Conversely, the effective use of split-MOPP procedures is one of the cornerstones of CW attack response.

- Use of personal equipment (M291/M295 kits[35]) to accomplish operational decontamination of resources and work areas is not a useful technique in the majority of BW attack situations because of the delay expected between attack and detection. This differs from CW attack scenarios where operational decontamination can be very useful if the personnel were unable to adequately protect their assets in the pre-attack phase.

- Biologically contaminated remains must be separated from chemically contaminated and uncontaminated remains. Further, biologically contaminated remains are separated into three distinct categories while they are temporarily stored: non-contagious pathogen (anthrax for example), contagious pathogen (smallpox for instance), and toxin (ricin would be an example).[36]

- The ongoing concern regarding the transportation of biological warfare casualties or contaminated remains across national or international boundaries complicates base response to biological events due to the contagion factor in many biological agents.

- Crisis management is a more important component of response to a biological event due to the latency of biological agents. Further, the requirement to identify and track those possibly exposed to a biological agent and the potential need to restrict or quarantine these individuals reiterates the importance of maintaining an accurate and continuous flow of information to the targeted populace. This is not necessarily the case when dealing with a CW attack.
- The likelihood of individuals in the surrounding base community to be exposed to a biological agent as the result of an attack against the base increases the need for a regularly exercised, integrated command and control (C2) structure for civilian-military interagency cooperation and resource sharing.
- Inhalation of BW is generally the greatest hazard concern and simple/inexpensive individual and collective protection measures may go a long way toward reducing risk. The Air Force has begun some analysis and experimentation on expedient BW protection.

Biological Detection

In the 1993 time frame, the Air Force had not developed or fielded a biological detector that could be used in a field environment to sample and provide early warning of airborne or surface contamination. It was a virtual certainty that BW detection would occur at a medical treatment facility through the exhibition of symptoms and/or slow (several hours to days) laboratory tests. Today, while not every installation possesses a full suite of BW agent detectors, and there are still significant issues in the area of BW agent detection, most air bases have some biological detection capability outside of the laboratory. Figure 8 provides a summary of the types of BW detectors commonly found at many Air Force installations.

Figure 8. BW Detectors Currently in use at USAF installations

Type BW Detector	Purpose	Location
DoD Sampling Kits (aka Hand-Held Assays)	Sampling of surface areas	Most CEX and BEE offices in the Air Force*
Portal Shield Network	Sampling of air at multiple places around installation	Several selected locations in high CB threat areas (Korea and SWA**); some CONUS*** units scheduled to receive system
Portable Collector Concentrators (Spincon, Dry Filter Units, Portable Biological Aerosol Sampler, etc.)	Sampling of air at location where portable collector concentrator is positioned (normally 1 – 3 per installation)	Selected locations in medium and high CB threat areas; some CONUS sites
Ruggedized Advanced Pathogen Identification Device (RAPID)	Identification of BW agent contained in environmental or fluid samples	Several medical facilities (normally maintained by BEE or laboratory personnel) throughout Air Force

***CEX – Civil Engineer; BEE – Bioenvironmental Engineer**
****SWA - Southwest Asia**
*****CONUS - Continental United States**

Automated Hazard Prediction Plotting

In 1993, the Air Force did not possess an approved biological hazard prediction plotting capability. In essence, since no guidance materials existed, the ad-hoc response of most CEX personnel was to plot BW agents in the same manner as the farthest reaching CW agents. Since that time, the Air Force has published manual BW hazard prediction plotting procedures.[37] More importantly, the Air Force distributed an automated BW hazard prediction plotting capability to each CE Readiness Flight. This automated plotting capability is contained within the VLSTRACK software package included as part of the Joint Warning and Reporting Network (JWARN) program. The Air Force provided training regarding automated

BW hazard prediction plotting at each Major Command C-CW CONOPS training session, to include provisions for a detailed step-by-step checklist.

Initiation of Joint Service Installation Pilot Program and Weapons of Mass Destruction First Responders Program

In 1993, the Air Force did not have a program that was specifically designed to provide installations with the equipment and training required to effectively respond to terrorist use of WMD. Although in its early stages, the Air Force has actively participated in Joint Service and Air Force-wide programs that are ultimately designed to significantly increase force protection at air bases. In the case of the *Joint Service Installation Pilot Project (JSIPP)*, networked BW sensors (Portal Shield) are scheduled to be placed at three CONUS bases initially, with follow-on installations identified if the program is proven to be cost-effective. First Responders and other Disaster Response Force members are scheduled to receive specialized terrorist attack response equipment as part of both the JSIPP and WMD First Responder's programs. The specific equipment items are contained on the Baseline Equipment Data Assessment List (BEDAL). Further, both programs possess a training component that highlights BW response actions and includes field and table top exercise events.

Availability of information

As stated earlier, in 1993 there was very little guidance available regarding response to BW attack situations. Since then, the Air Force, DoD, and other United States government agencies have developed and published a wide range of reference and procedural guidance documents. While much work remains to be done, the following list provides some insight into how much more information is readily available today as compared to 1993.

- Interim Biological Defense Plan. Prepared by an Air Force level Biological Defense Task Force (BDTF), distributed to the major commands, and posted on the AF/XOS-FC website.[38] The execution tasks within this document are being combined into the standardized Full Spectrum Threat Response (FSTR) 10-2 template. NOTE: This document did not exist in 1993.

- FSTR 10-2 template. This template is used by all Air Force installations as the starting point for developing the installation FSTR 10-2 plan. Installation responses to BW attack and terrorist use of BW agents are required portions of this plan, with the information being located in Annex C (Enemy Attack) and Annex D (Terrorist Use of WMD) respectively. NOTE: This standardized template did not exist in 1993. In fact, in 1993, it was not a requirement for the installation Disaster Preparedness Operations Plan to have an Annex outlining response procedures for a terrorist attack involving WMD.
- AFMAN 10-2602 and AFMAN 32-4017 both contain informational segments regarding BW agents and delivery systems. NOTE: These documents did not exist in 1993.
- AF Handbook 10-2502, USAF WMD Threat Planning and Response Handbook, contains information outlining how to tell if a BW attack has occurred, what response actions are appropriate, and agent-specific material. NOTE: This document did not exist in 1993.
- The current NBCC Defense Course contains far more BW-related information than the corresponding course in 1993. In 1993, the course material was constrained to limited protective actions individuals should take before, during, and after a BW attack. The current course discusses agent characteristics, delivery methods, recognition of trigger events, and decontamination methods in addition to containing information that addresses protective actions.
- In 1993, few had access to the Internet, and the Web was just coming into existence. Since then, it has become a valuable conduit for distributing information about biological defense-related activities. A few examples of information available on the Web are:
    - USAF Counterproliferation Center: http://www.au.af.mil/au/awc/awcgate/awc-cps.htm.

- DoD Anthrax Vaccine Immunization Program: http://www.anthrax.osd.mil.
- The AF/XOS-FC Commanders' ChemBio Website is a repository for all current Air Force guidance on chemical and biological warfare response: https://www.xo.hq.af.mil/af/xo/xos/xosf/xosfc/ccbrne_resource/index.ays.
- BW agent technical information and fact sheets from the Center for Disease Control (CDC): http://www.bt.cdc.gov/Agent/Agentlist.asp.
- The Medical Management of Biological Casualties handbook from the U.S. Army Medical Research Institute of Infectious Diseases can be downloaded from: http://www.usamriid.army.mil/education/bluebook.html.

Development and initiation of specific handling and packaging criteria for BW samples

In 1993, the Air Force did not have published procedures or criteria for the handling and packaging of BW samples, to include chain-of-custody requirements. This information is now contained in documents such as AFMAN 10-2602 and the Interim Biological Defense Plan, with Air Force personnel (mostly CEX and BEE) taking courses and receiving certification for handling/packaging activities through the International Air Transport Association.

IX. Nuclear and Radiological Threat and Current Initiatives

The biggest differences between the 1993 time period and the present in regard to nuclear attack response techniques involve the following items.

Detection Equipment

The Air Force has replaced up to four separate radiation instruments with the ADM 300, a detector with far superior capabilities. The largest improvements are the ADM 300's ability to detect all types of radiation of interest, the digital readings versus scale depictions – which provides increased accuracy, and the ability to set audio warning alarms. (See Figure 9.) In addition to directly translating to operational advantages, this has lessened the maintenance times required, reduced the numbers and types of consumable supplies (such as batteries on hand,) simplified the training requirements, etc.

Figure 9. Various Radiation Instruments and their Individual Operational Capabilities

TYPE OF INSTRUMENT	TYPE OF RADIATION DETECTED/MEASURED	SPECIFICITY OF READING
AN/PDR 56F	Alpha, X-Ray	Needle on Scale
PAC 1S	Alpha	Needle on Scale
AN/PDR 27	Beta, Gamma (low range)	Needle on Scale
AN/PDR 43	Beta, Gamma (high range)	Needle on Scale
ADM 300	Alpha, Beta, Gamma, Neutron, X-Ray	Specific digital reading

Awareness of Hazards Associated with Depleted Uranium (DU)

As a result of exposures that personnel received during and after Operation Desert Storm, the Air Force instituted a DU awareness training program. This training was made a mandatory part of the NBCC Defense courses that everyone “in or deployable to a medium or high CB threat area” is required to receive. This training segment consists of information that defines addressing what DU is, the specific sources that personnel may come into contact with, the hazards associated with the material, and protective actions that can be taken.

Awareness and ability to respond to attacks involving Radiation Dispersal Devices (RDD)

Radiation weapons were not considered a mainstream threat within the Air Force in 1993. Consequently, there was no specific training on the subject for Air Force personnel unless they were assigned to a highly specialized, national-level team such as the Nuclear Emergency Search Team (NEST). At the present time, more information is available to the Air Force population regarding the characteristics of radiation weapons and additional information has been incorporated into hazardous material training courses and in Air Force policy and guidance.[39]

- Deployable units have an automated RDD plotting capability available in every CEX Flight. The Hazard Prediction and Assessment Capability (HPAC) software can predict areas and intensities of radiation contamination that was distributed as part of the JWARN program.
- The Full-Spectrum Threat Response plan contains requirements for all Air Force installations to develop procedures for response to situations where the air base is in the downwind hazard plume of a radiation weapon.[40]

Modification of installation response mechanisms regarding enemy attacks involving nuclear weapons

The Air Force NBCC defense programs remain focused on the dominant threat(s) at the time. Consequently, there has been a de-

emphasis on nuclear warfare response activities from 1993 to the present, with a corresponding increase focusing on other threats. For example, the historically nuclear-oriented shelter management training requirements in Table 9.3 of Air Force Instruction (AFI) 10-2501 state that "installations assessed as low threat areas will train only upon increase in threat posture or as directed by Air Staff, with the exception of covering natural disaster sheltering." This shift in philosophy is also contained in such AFMAN 32-4005 items as:

- In addition to response to nuclear attack, installation protective shelters can be used for major accidents, natural disasters, and other civil emergency relief operations. This includes specifying that Air Force units are allowed to use War Reserve Materiel (WRM) supplies to support shelter operations for major accidents, natural disasters, and other civil emergency relief operations.
- Differing numbers of required shelter management team members for nuclear attack, CB attack, and natural disaster/major accident response situations need to be specified.
- Radiological exposure control procedures need only be developed for each shelter if the threat warrants.

X. Summary and Way Ahead

The Air Force has made dramatic improvements in countering WMD over the past decade. In the area of chemical warfare, results from testing and analyses showed quite convincingly that many previously accepted operational concepts were based on inaccurate assumptions and were largely ineffective. Whereas previously a "worst case" operating environment had been assumed, new information about the physical characteristics of chemical agents, agent sorption, and the expected delivery methods led to the conclusion that the "worst case" scenario was unlikely. While the effects of a CW attack are still not trivial, commanders implementing the C-CW CONOPS can now make risk assessments and informed decisions in order to continue the war fight. At the operational level, through active defense, counterforce operations, and passive defense, much of the current CW threat can be negated.

The Air Force needs to continue to capitalize on this momentum, especially in the area of testing. Additional testing in agent fate is still needed in order to validate and extend the results of the existing testing and analyses. Due to uncertainties inherent in the data, operational commanders must understand the risks inherent in the hazard durations ranges and take a conservative approach to ordering measures (e.g., reductions in MOPP levels) to restore operational capability and reduce the physical stress placed on personnel. Sustainment requirements, such as institutionalized training, are also still necessary at all levels of the Air Force. Further research and analysis is also needed to determine the proper attack response procedures when considering fourth generation chemical agents and other possible future improvements in chemical warfare.

In the area of biological warfare defense, the Air Force has begun to make great strides in recognizing that, although the same or greater rigor applied to the chemical warfare threat is necessary, responding to biological threats is very different and more challenging. As a result, the Air Force has implemented a vaccination program, bio-specific hazard prediction plotting, and has also published a wide range of reference and procedural guidance documents for understanding and responding to a biological warfare event.

The Air Force has also continued to hone response procedures to counter nuclear and radiological threats. As a result of the re-emergence

of nuclear and radiological warfare as realistic threats, the Air Force has dramatically improved its capability to detect these types of weapons and has significantly increased its training and education in the area of hazardous exposure to nuclear and radiological material.

In the future, the weapons of mass destruction capabilities of adversaries will continue to grow and become more sophisticated. To counter them, the Air Force must continue its significant material and operational investment in command and control, passive defense, active defense and attack operations as well as training, education and CONOPS development to fight and help win the nation's wars.

Notes

1. Donald H. Rumsfeld, Secretary of Defense, Testimony before the House Armed Services Committee, 28 June 2001.

2. MOPP level 4 is the highest level of MOPP gear and requires the wearing of overgarment, field gear (helmet, web belt, canteen and, if used, body armor (worn over the overgarment)), footwear covers (overboots), mask, hood, and gloves. It is used when the highest degree of CB protection is required, such as Alarm Black notification and also post-attack reconnaissance-until the actual hazard has been determined. Only the installation commander can direct the change in MOPP levels. Notional MOPP levels for forces ashore are presented as follows in Joint Doctrine for Operations in NBC Environments, 11 July 2000:

	Level 0	Level 1	Level 2	Level 3	Level 4
Overgarment	Readily available	Worn	Worn	Worn	Worn
Overboots	Readily available	Carried	Worn	Worn	Worn
Mask & Hood	Carried	Carried	Carried	Worn	Worn
Gloves	Readily available	Carried	Carried	Carried	Worn

3. Col Glenn Burgess, USMC (ret), "Counter Chemical Warfare CONOPS Now…Survive and Operate," *Marine Corps Gazette*, Marine Corps Association, Quantico, VA, December 2002, 47.

4. "Senior Leader's Guide," Update 2002, 5. Headquarters Air Force Civil Engineer Support Agency HQ AFCESA/CEXR Tyndall AFB, FL.

5. USAF Counter-Chemical Warfare Concept of Operations, XONP/ILEX, Washington D.C., 2 Jan 2002.

6. "Senior Leader's Guide," Update 2002, 8.

7. In the past, MOPP postures were largely binary—which meant the entire base populace was generally in either a MOPP 2 or MOPP 4 posture following an attack. The C-CW CONOPS includes procedures for determining which areas of a base are contaminated and which are clean so that personnel operating in clean areas can reduce MOPP levels according to sectors. It also includes procedures for split-MOPP within a sector. Personnel adopt the appropriate MOPP, as directed by installation leadership, based on their proximity to contaminated areas or surfaces.

8. "Senior Leader's Guide," Update 2002, 7.

9. Some of these include: CORAL BREEZE (Summer 1996 – Spring 1997), CHEMWAR 2000 (Fall 1997), and TAEBEK'97 (Fall 1997).

10. Some examples of nerve agents include GA (Tabun), GB (Sarin), GD (Soman), GF (Cyclosarin), and VX. Nerve agents attack the nervous system and affect muscle control, vision, heart, and lung functions. Some examples of blister agents include H (Sulphur Mustard), HD (Distilled Mustard), HN-1 (Nitrogen Mustard), and L (Lewisite). Blister agents attack and destroy cell tissue. They cause skin and eye irritation, inflammation, and severe blisters. This tissue damage increases the chance of infection and may ultimately cause death. In most cases, pain and blisters may not occur until long after exposure.

11. In 1997, the Air Force and DTRA conducted an operational study of strategic air mobility operations in a chemically contaminated environment (it is referred to commonly as the APOD Study.) Based on the results of the study, other "excursion studies" were conducted, the total of which are referred to as the "APOD family of studies."

12. Live agent testing: testing using actual chemical warfare agents on actual air base operating surfaces.

13. Results from live agent testing on duration: The first tests were sponsored by the Air Staff and DTRA between August 1998 and May 1999, and held at Dugway, West Desert Test Center in Utah. These tests examined the persistence of VX and two of its isomers as liquid and vapor hazards on concrete and asphalt (samples taken from air bases) at three temperatures. The second test was conducted in two phases from May 1998 through August 1999. This test was sponsored by the Joint Service Materiel Group (JSMG) Decontamination Commodity Area Manager, and held in the Czech Republic. This test examined persistence of VX (nerve), GD (nerve), and HD (blister) agents on grass, sand, concrete, and asphalt. A third live-agent test was conducted by the Naval Surface Warfare Center in Dahlgren, Virginia, during the spring of 1999, focusing on the liquid and vapor hazard generated over time from VX, HD, and thickened GD agents sorbed into surfaces. Each of these tests concluded that liquid agents rapidly sorb into a wide range of porous surfaces, quickly removing the liquid pickup and transfer hazard. The Dugway results were robust and held true for dry and wet surfaces, surfaces with paint and rubber deposits, as well as surfaces contaminated with petroleum, oil, and lubricants. All shed light on two primary issues affecting air base operations in wake of a chemical attack: persistence of the liquid contact hazard and duration of the vapor hazard of agent sorbed into surfaces.

14. PACAF C-CW CONOPS: The risk assessment methodologies, command and control tools, and detailed information on the tactics, techniques and procedures

associated with this C-CW CONOPS can be found in USAF publications, including AFMAN 10-2602, NBCC Defense Operations and Standards, and AFMAN 10-2603, Counter-NBCC Defense Commander's Guide, NBCC Commander's Guide.

15. "Senior Leader's Guide," Update 2002, 7.

16. The CSAF directed that COMPACAF operating procedures become the USAF Counter-Chemical Warfare concept of operations.

17. See note 7.

18. See note 20 on detectors.

19. The term "sorb" is a term of art within the community reflecting the various interactions that occur between liquid agents and surfaces with which they come into contact. This includes the traditional absorption (the wholesale soaking in of a substance) and adsorption (sticking of individual molecules to a surface, like activated charcoal scavenging poisonous gases in gas masks) as well as the more complicated chemical interactions of physisorption and chemisorption.

20. Some examples of detectors include: M8 and M9 paper, M256 A1, and the Chemical Agent Monitor. The M8 paper will detect liquid G and V nerve agents and H blister agents. M8 paper provides the user with a manual liquid detection capability. Technical Order (T.O.) 11H2-14-5-1 is the technical reference. M9 paper, like M8 paper, contains agent sensitive dyes that change color in the presence of liquid chemical agent. M9 paper will turn different colors if liquid agent comes in contact with paper. Color changes to M9 paper identify agent presence, not agent type. T.O. 11H2-2-21 is the technical reference. The M256A1 Chemical Agent Detector Kit manually detects and classifies nerve, blister, and blood agents in vapor or liquid form. The M256A1 sampler-detectors are capable of detecting and identifying vapors only. T.O. 11H2-21-1 is the technical reference. The Chemical Agent Monitor (CAM) is a hand-held point monitor capable of detecting and identifying nerve and mustard agent vapors. CAMs are intended for use to search out clean areas, and to identify contaminated personnel, equipment, aircraft, vehicles, buildings, and terrain. CAMs can help determine the effectiveness of decontamination and can be used in collective protection shelters. The CAM is a monitor, not a detector, and can become contaminated or overloaded (saturated) if not used properly. The CAM can only detect vapors at the inlet nozzle. It will not give the vapor hazard over an area. The CAM is currently the best fielded device we have to at least approximate the concentrations of chemical agent vapors present at any given time. While it does not provide a digital readout with exact chemical concentrations, the CAM's individual bars do equate to intensity ranges. T.O.11H2-20-1 is the technical reference for inspection and use. Endnote 31 provides additional detection information.

21. There are many tables based on varying agent-surface-environmental conditions listed in the NBC Detection Guide published by HQ AFCESA, 21 on March 2003. These tables are based on static weather conditions throughout the entire hazard duration listed; uncertainty in actual hazard durations lies with real-time variance in these conditions.

22. Air bases use primarily alkyd- or polymer-based paints, including latex, epoxy, polyurethane, and acrylic. Each paint, including Chemical Agent Resistant Coating (CARC), exhibits unique characteristics in different situations. These include the diffusion and transport of the agents across the surface, the vapor evaporation rates based on the wetted surface area, the rate at which agent penetrates the surface as a function of time, the transferability of agent from the painted surface to materials that contact the paint surface (dependent on the two surfaces, the type of agent, and type of contact), and the rate at which agents off-gas after they are sorbed into the paint. The USAF does own some CARC-painted equipment; however, the CARC-painted vehicles (usually operated by Security Forces) have not received the maintenance necessary to maintain CARC's anti-absorbent capability.

23. For additional information, please refer to AFMAN 10-2602, *NBCC Defense Operations and Standards*, Interim Change, 23 May 2003, Attachment 2.

24. See note 11.

25. Based on compilation of results of 8 air bases from the Operational Effectiveness Assessment studies, which include the completed analysis of operations at 15 USAF installations.

26. Restoration of Operations (RestOps) Advanced Concept Technology Demonstration (ACTD): RestOps was a collaborative initiative between United States Pacific Command (PACOM), United States Central Command (CENTCOM), United States Transportation Command (TRANSCOM), Pacific Air Forces (PACAF), United States Forces Korea (USFK), United States Air Force (USAF), Defense Threat Reduction Agency (DTRA), West Desert Test Center (WDTC) at Dugway Proving Ground (DPG), Detachment 1, Air Force Operational Test and Evaluation Center (Det 1, AFOTEC), Joint Service Materiel Group (JSMG) (Joint NBC Defense Program), Joint Service Integration Group (JSIG) (Joint NBC Defense Program), Center for Counterproliferation Research, National Defense University (NDU), Edgewood Chemical Biological Center (ECBC), Soldier Biological and Chemical Command (SBCCOM), Joint Program Office - Biological Defense (JPO-BD), Institute for Defense Analyses (IDA) and the Department of Energy (DOE). The Air Force was the lead service and DTRA was the executing agent.

As written in the March 2000 Management Plan, the RestOps ACTD was designed to demonstrate mitigating actions taken before, during and after an attack to protect against and immediately react to the consequences of a Chemical/Biological attack.

These actions aim to restore OPTEMPO in mission execution and the movement of individuals and materiel to support combat operations at a fixed site.

27. See note 25.

28. VLSTRACK training sessions were conducted at each MAJCOM Orientation C-CW CONOPS training (Jan 02 – Dec 02). CW and Biological Warfare (BW) VLSTRACK checklists were provided as handouts to walk the student through the plotting sessions.

29. Three years of analysis and testing, sponsored by AF/XON, the Defense Threat Reduction Agency, the Joint Service Materiel Group, and the Navy Surface Warfare West Desert Center at Dahlgren, provided a greater understanding of chemical effects on air base operating surfaces.

30. The M17A/A2 Decontamination Apparatus provides the user with a portable decontaminating capability. The system consists of a pump/heater assembly, two spray wands, each with 20 meters of high pressure hose, 12 shower points, 10 meters of suction hose with filter, and an injector for chemical decontaminant. T.O. 11D1-3-9-1, 11D1-3-9-2, and 11D1-3-9-1CL-1 are the technical references.

31. While serious deficiencies still exist, the Air Force fielded two improved chemical agent detectors over the past decade. The additions were the Improved Chemical Agent Monitor (ICAM) and the M22 Automatic Chemical Agent Detector and Alarm (ACADA). The ICAM's primary enhancements over the original Chemical Agent Monitor (CAM) were the ability to automatically switch scales from nerve to blister and the ability to provide an audio alarm when a specified concentration (3 bars) was achieved. The M22's primary enhancement over the M8A1 is the ability to simultaneously detect nerve and blister agents; the M8A1 was a nerve agent only detector.

32. The issue surrounding Air Force-wide IPE supply requirement shortfall is gaining attention by the USAF, as noted in the 2003 Annual Report to Congress Vol I, April 2003. This document may be referenced for further information on this topic.

33. The issues listed are the main issues and do not represent the full spectrum of issues requiring further attention. For additional reading on such issues, documents such as: AFMAN 10-2602 Paras 1.18; AFJMAN 44-151 –NATO Handbook on Medical Apects of NBC Defense and Operations; AFMAN 44-156(I) – Treatment of Biological Warfare Agent Casualties.

34. AFMAN 32-4005, Personnel Protection and Attack, 30 October 2001, HQ AFCESA/CEXR, Tyndall AFB, FL.

35. The M291 Skin Decontaminating Kit provides the user capability to completely decontaminate through physical removal, absorption, and neutralization of chemical agents on the skin. This wallet-sized kit contains six separately packaged laminated pads soaked with the nontoxic decontaminant AMBERGARD XE-555. Ambergard absorbs and neutralizes chemical agent. M291 pads are to be used to wipe skin, clothing, masks, gloves, personal equipment, and weapons. The six pads of an M291 kit should be sufficient for three personal decontaminations. The kit operates in ranges from -50°F to 120°F. Technical Order (T.O.) 11D1-1-131 is the technical reference. The M295 Equipment Decontamination Kit allows the individual to decontaminate their equipment through physical removal and absorption of chemical agents. Each M295 Kit consists of a carrying pouch containing four individual decon packets. Each packet contains a decon mitt filled with decon powder. The packet is designed to fit comfortably in the pocket of the ground crew ensemble. Each individual mitt is comprised of absorbent resin contained within a nonwoven polyester material. The kit operates in ranges from -25°F to 180°F. TM-3-4230-235-10 is the technical reference.

36. Per AFMAN 44-156 (I), Treatment of Biological Warfare Agent Casualties.

37. Contained in Air Force Manual (AFMAN) 32-4005, CE Readiness Technician's Manual for NBC Defense.

38. *AF/XOS-FC website.* On-line, Internet, available from https://www.xo.hq.af.mil/xos/xosf/xosfc/.

39. Reference Attachment 2 of AFMAN 10-2602, NBCC Defense Operations and Standards, and Attachment 13 of AFMAN 32-4005, Personnel Protection and Attack Actions.

40. Air Force installations are required to include a section on responding to situations where the air base is in the downwind hazard plume of an RDD in Annex C of their Full Spectrum Threat Response (FSTR) Plan 10-2. This requirement is specified in Attachment 3 of AFI 10-2501, FSTR Planning and Operations.

USAF Counterproliferation Center

The USAF Counterproliferation Center was established in 1999 to provide education and research to the present and future leaders of the USAF, to assist them in their activities to counter the threats posed by adversaries equipped with weapons of mass destruction

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